Translation

PCT/JP2004/003937

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P0697PC	FOR FURTHER ACTION	See Form PCT/IPEA/416
International application No. PCT/JP2004/003937	International filing date (*day/month/year*) 23 March 2004 (23.03.2004)	Priority date (*day/month/year*) 15 April 2003 (15.04.2003)
International Patent Classification (IPC) or national classification and IPC G02F 1/01		
Applicant JAPAN SCIENCE AND TECHNOLOGY AGENCY		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

3. This report is also accompanied by ANNEXES, comprising:

   a. ☒ *(sent to the applicant and to the International Bureau)* a total of 11 sheets, as follows:

      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).

      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) ________________, containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

   ☒ Box No. I Basis of the report
   ☐ Box No. II Priority
   ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   ☐ Box No. IV Lack of unity of invention
   ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   ☐ Box No. VI Certain documents cited
   ☐ Box No. VII Certain defects in the international application
   ☐ Box No. VIII Certain observations on the international application

Date of submission of the demand 14 February 2005 (14.02.2005)	Date of completion of this report 18 May 2005 (18.05.2005)
Name and mailing address of the IPEA/JP Facsimile No.	Authorized officer Telephone No.

Box No. I Basis of the report

1. With regard to the language, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language ____________ , which is language of a translation furnished for the purpose of:

   ☐ international search (under Rules 12.3 and 23.1(b))

   ☐ publication of the international application (under Rule 12.4)

   ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the elements of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

   ☐ The international application as originally filed/furnished

   ☒ the description:

   pages 1-22, as originally filed/furnished
   pages* ____________ received by this Authority on ____________
   pages* ____________ received by this Authority on ____________

   ☒ the claims:

   pages 2,4,7,9,10,13, as originally filed/furnished
   pages* ____________, as amended (together with any statement) under Article 19
   pages* 1,3,5,6,8,11,12,14,15 received by this Authority on 14 February 2005 (14.02.2005)
   pages* ____________ received by this Authority on ____________

   ☒ the drawings:

   pages 1-7,10, as originally filed/furnished
   pages* 8,9 received by this Authority on 14 February 2005 (14.02.2005)
   pages* ____________ received by this Authority on ____________

   ☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

   ☐ the description, pages ____________
   ☐ the claims, Nos. ____________
   ☐ the drawings, sheets/figs ____________
   ☐ the sequence listing *(specify)*: ____________
   ☐ any table(s) related to sequence listing *(specify)*: ____________

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

   ☐ the description, pages ____________
   ☐ the claims, Nos. ____________
   ☐ the drawings, sheets/figs ____________
   ☐ the sequence listing *(specify)*: ____________
   ☐ any table(s) related to sequence listing *(specify)*: ____________

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

Box No. V **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-15	YES
	Claims		NO
Inventive step (IS)	Claims	1-15	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-15	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The subject matters of claims 1-15 appear to involve an inventive step over the documents cited in the ISR.

The documents cited in the ISR do not describe that, with an optical filter and an optical phase-modulator inserted before an optical Fourier transformation device having a dispersive medium, optical pulses of temporal waveforms according to the frequency characteristics of the optical filter are generated by the optical Fourier transformation device, whereby the compression of optical pulses and the generation of optical functions are performed.

Documents:
Document 1: JP, 9-61765, A (Hitachi, Ltd.), 7 March, 1997 (07.03.97)
Document 2: JP, 11-112425, A (Nippon Telegraph and Telephone Corp.), 23 April, 1999 (23.04.99)
Document 3: Time-Domain Fourier Optics for Polarization-Mode Dispersion Compensation, (M. Romagnoli, et al.), Optics Letters, September 1999, Vol. 24, No. 17, pages 1197-1199
Document 4: Timing Jitter Eater for Optical Pulse Trains, (A. Leaf, et al.), Optics Letters, January 2003, Vol. 28, No. 2, pages 78-80

CLAIMS

1. (Amended)

An optical pulse compressor comprising:

an optical Fourier transform circuit for converting the shape of the frequency spectrum of an input optical pulse to a time waveform, the optical Fourier transform circuit having an optical phase modulator driven at the repetition frequency of the input optical pulse train and a dispersive medium; and

an narrow-band optical filter for narrowing the spectrum width of the input optical pulse, the narrow-band optical filter being inserted before the optical Fourier transform circuit,

wherein the optical Fourier transform circuit converts an optical pulse having a narrow spectrum width output from the narrow-band optical filter to an optical pulse having a time width narrower than the input pulse width before the optical filter.

2. An optical pulse compressor according to Claim 1, wherein a Fourier-transform-limited pulse is used as the input optical pulse.

3. (Amended)

An optical pulse compressor according to Claim 1, wherein the narrow-band optical filter has a variable spectrum band; and

the optical pulse compressor implements pulse compression with a compression ratio which can be varied in the time domain by increasing the amount of chirp given by the optical Fourier transform circuit largely by broadening the pulse width of the input optical pulse intentionally in accordance

with the spectrum band and by making the resultant spectrum broader than the spectrum of the input pulse.

4. An optical pulse compressor according to Claim 1, wherein the optical phase modulator is driven at a clock frequency reproduced from the input optical pulse train, and linearly chirps the input optical pulse; and

the dispersive medium gives group velocity dispersion.

5. (Amended)

An optical pulse compressor comprising:

an optical Fourier transform circuit for converting the shape of the frequency spectrum of an input optical pulse to a time waveform, the optical Fourier transform circuit having an optical phase modulator driven at the repetition frequency of the input optical pulse train and a dispersive medium; and

an narrow-band optical filter for narrowing the spectrum width of the input optical pulse, the narrow-band optical filter being inserted before the optical Fourier transform circuit,

wherein the optical Fourier transform circuit converts an optical pulse having a narrow spectrum width output from the narrow-band optical filter to an optical pulse having a time width narrower than the input pulse width before the optical filter,

in the optical Fourier transform circuit,

the dispersive medium gives group velocity dispersion to the optical pulse output from the narrow-band optical filter;

the optical phase modulator is driven at a clock frequency reproduced from the input optical pulse train, and linearly chirps the optical pulse output from the dispersive medium; and

the dispersive medium receives the optical pulse output from the optical phase modulator, gives group-velocity dispersion again, and compensates for the remaining chirp.

6. (Amended)

An optical pulse compressor comprising:

an optical Fourier transform circuit for converting the shape of the frequency spectrum of an input optical pulse to a time waveform, the optical Fourier transform circuit having an optical phase modulator driven at the repetition frequency of the input optical pulse train and a dispersive medium; and

an narrow-band optical filter for narrowing the spectrum width of the input optical pulse, the narrow-band optical filter being inserted before the optical Fourier transform circuit,

wherein the optical Fourier transform circuit converts an optical pulse having a narrow spectrum width output from the narrow-band optical filter to an optical pulse having a time width narrower than the input pulse width before the optical filter,

in the optical Fourier transform circuit,

the optical phase modulator is driven at a clock frequency reproduced from the input optical pulse train, and linearly chirps the optical pulse output from the narrow-band optical filter;

the dispersive medium gives group-velocity dispersion to the optical pulse output from the optical phase modulator; and

the optical phase modulator receives the optical pulse output from the dispersive medium, gives another linear chirp, and compensates for the remaining chirp.

7. An optical pulse compressor according to Claim 1,

wherein the chirp rate K of phase modulation by the phase modulator and the group-velocity dispersion D of the dispersive medium satisfy a relationship of K = 1/D.

8. (Amended)

An optical function generator comprising:

an optical pulse generator for generating an optical pulse train;

an optical Fourier transform circuit for converting the shape of the frequency spectrum of the optical pulse input from the optical pulse generator to a time waveform, the optical Fourier transform circuit having an optical phase modulator driven at the repetition frequency of the input optical pulse train from the optical pulse generator and a dispersive medium; and

an optical filter for shaping the spectrum of the input optical pulse and determining the time waveform of the output optical pulse in accordance with frequency characteristics, the optical filter being inserted before the optical Fourier transform circuit,

wherein the optical Fourier transform circuit generates an optical pulse having a desired time waveform depending on the function form of the frequency characteristics of the optical filter, by reproducing, directly in the time domain, the spectrum shaped as desired by the optical filter.

9. An optical function generator according to Claim 8, wherein a Fourier-transform-limited pulse is used as the input optical pulse.

10. An optical function generator according to Claim 8, wherein

the optical phase modulator is driven at a clock frequency reproduced from the input optical pulse train, and linearly chirps the input optical pulse; and

the dispersive medium gives group-velocity dispersion.

11. (Amended)

An optical function generator comprising:

an optical pulse generator for generating an optical pulse train;

an optical Fourier transform circuit for converting the shape of the frequency spectrum of the optical pulse input from the optical pulse generator to a time waveform, the optical Fourier transform circuit having an optical phase modulator driven at the repetition frequency of the input optical pulse train from the optical pulse generator and a dispersive medium; and

an optical filter for shaping the spectrum of the input optical pulse, the optical filter being inserted before the optical Fourier transform circuit,

wherein the optical Fourier transform circuit generates an optical pulse having a desired time waveform, by reproducing, directly in the time domain, the spectrum shaped as desired by the optical filter,

in the optical Fourier transform circuit,

the dispersive medium gives group-velocity dispersion to the optical pulse output from the optical filter;

the optical phase modulator is driven at a clock frequency reproduced from the input optical pulse train, and linearly chirps the optical pulse output from the dispersive medium; and

the dispersive medium receives the optical pulse output from the optical phase modulator, gives group-velocity

dispersion again, and compensates for the remaining chirp.

12. (Amended)

An optical function generator comprising:

an optical pulse generator for generating an optical pulse train;

an optical Fourier transform circuit for converting the shape of the frequency spectrum of the optical pulse input from the optical pulse generator to a time waveform, the optical Fourier transform circuit having an optical phase modulator driven at the repetition frequency of the input optical pulse train from the optical pulse generator and a dispersive medium; and

an optical filter for shaping the spectrum of the input optical pulse, the optical filter being inserted before the optical Fourier transform circuit,

wherein the optical Fourier transform circuit generates an optical pulse having a desired time waveform, by reproducing, directly in the time domain, the spectrum shaped as desired by the optical filter,

in the optical Fourier transform circuit,

the optical phase modulator is driven at a clock frequency reproduced from the input optical pulse train, and linearly chirps the optical pulse output from the optical filter;

the dispersive medium gives group-velocity dispersion to the optical pulse output from the optical phase modulator; and

the optical phase modulator receives the optical pulse output from the dispersive medium, gives another linear chirp, and compensates for the remaining chirp.

13. An optical function generator according to Claim 8,

wherein the chirp rate K of phase modulation by the phase modulator and the group-velocity dispersion D of the dispersive medium satisfy a relationship of K = 1/D.

14. (Amended)

An optical pulse compression method using an optical pulse compressor comprising an optical Fourier transform circuit and a narrow-band optical filter, the optical Fourier transform circuit having an optical phase modulator and a dispersive medium, and converting the shape of the frequency spectrum of an input optical pulse to a time waveform, the optical pulse compression method including that:

narrowing the spectrum width of an input optical pulse by inserting the narrow-band optical filter before the optical Fourier transform circuit;

driving the optical phase modulator at the repetition frequency of the input optical pulse train; and

converting the optical pulse having a narrow spectrum width output from the narrow-band optical filter to an optical pulse having a narrow time width, by means of the optical Fourier transform circuit.

15. (Amended)

An optical function generation method using an optical function generator comprising an optical pulse generator, an optical Fourier transform circuit, and an optical filter, the optical Fourier transform circuit having an optical phase modulator and a dispersive medium, the optical function generation method including that:

shaping the spectrum of an input optical pulse from the optical pulse generator, and determining the time waveform of the output optical pulse in accordance with frequency

characteristics, by inserting the optical filter before the optical Fourier transform circuit;

driving the optical phase modulator at the repetition frequency of the input optical pulse train; and

generating an optical pulse having a desired time waveform, depending on the function form of the frequency characteristics of the optical filter, by reproducing, directly in the time domain, the spectrum shaped as desired by the optical filter, by means of the optical Fourier transform circuit.

10/553649
(Amendment)

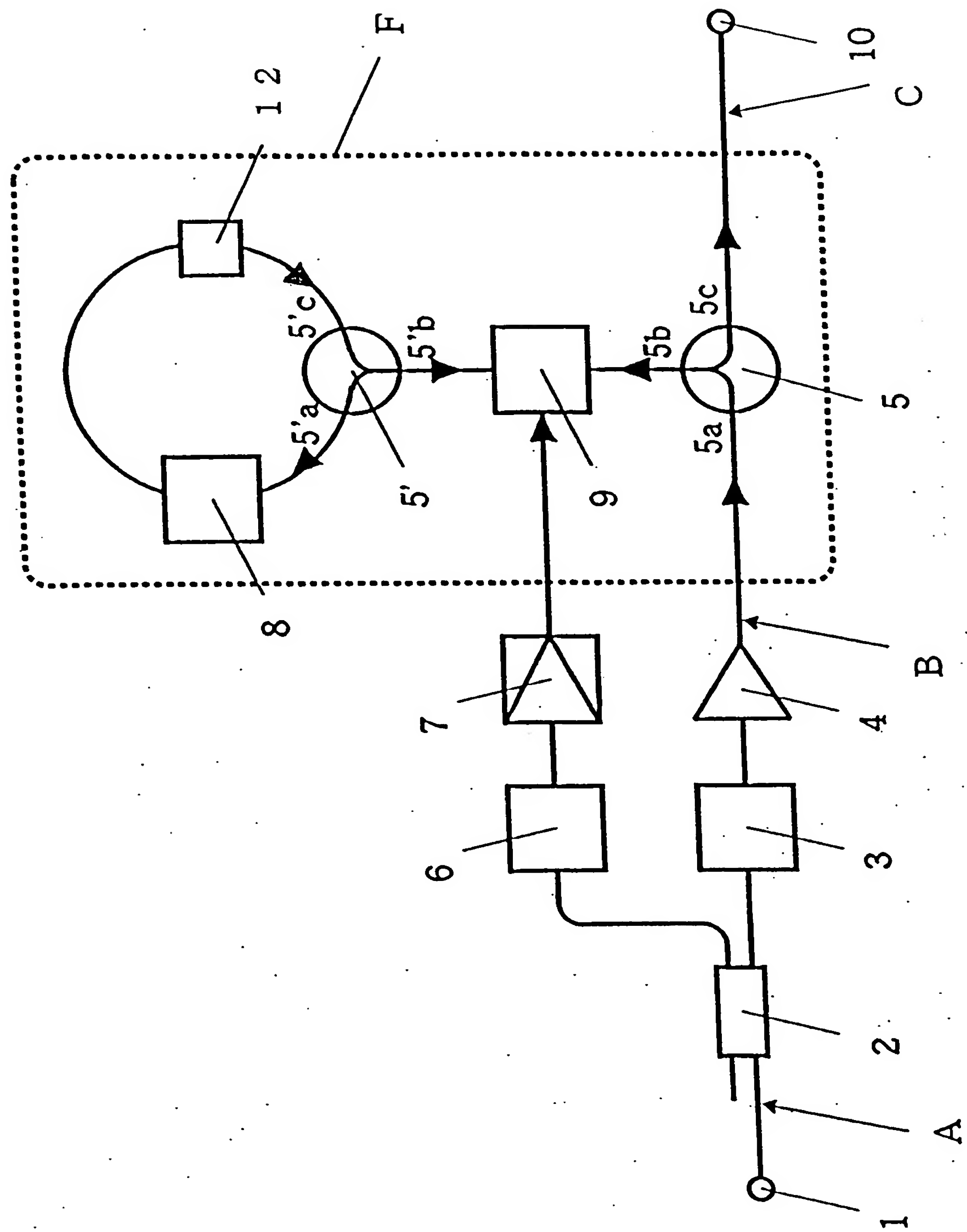

FIG.8

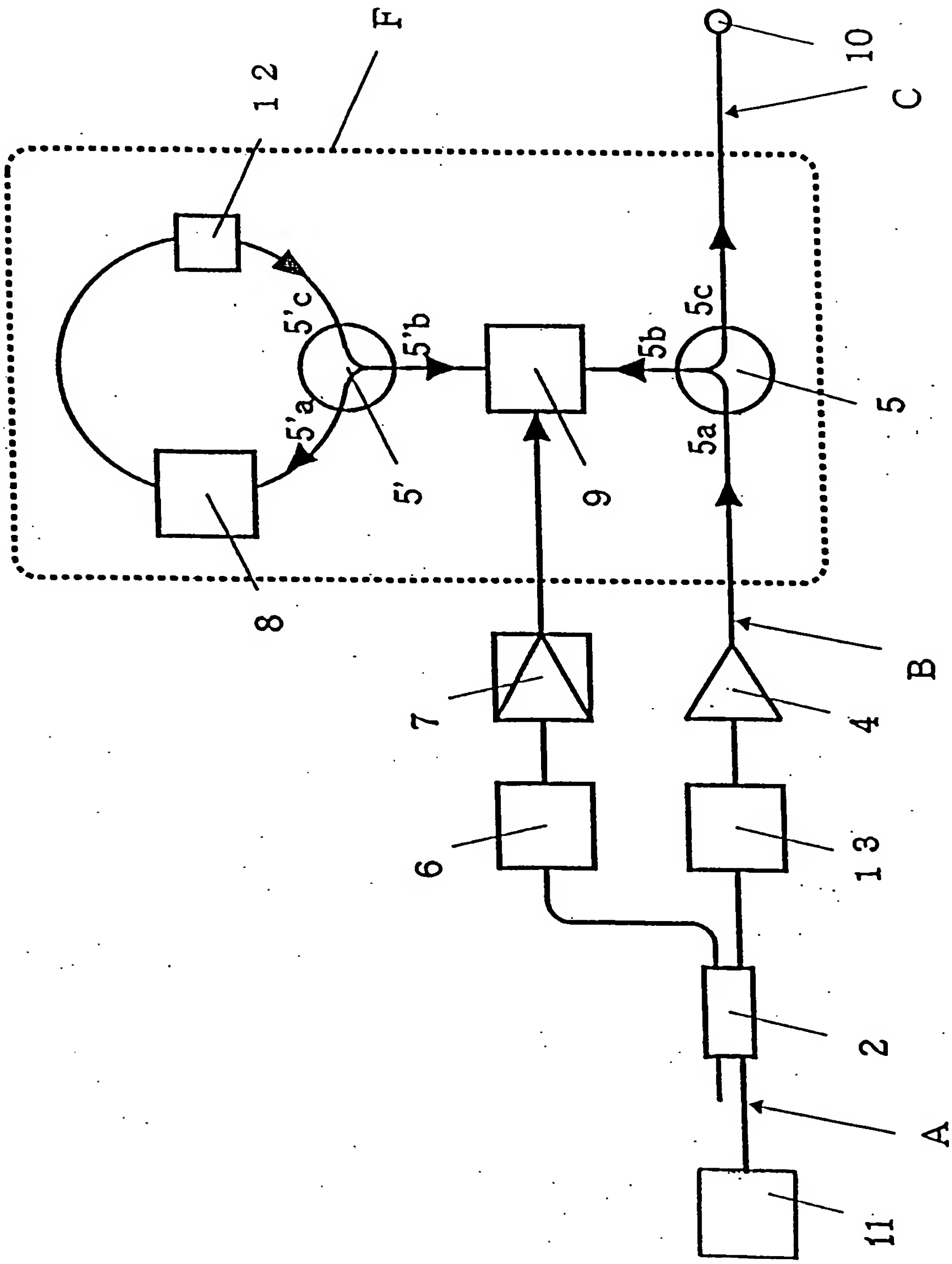

FIG.9